DP Barcode :D177705
PC Code No. :099101
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TO: Linda Propst
Product Manager PM 73
Special Review and Reregistration Division (H7508W)

FROM: Akiva D. Abramovitch, Ph.D., Head
Environmental Chemistry Review Section #3
Environmental Fate & Ground Water Branch/EFED (H7507C)

THRU: Henry Jacoby, Chief
Environmental Fate & Ground Water Branch/EFED (H7507C)

Attached, please find the EFGWB review of...

Reg./File # :099101

Common Name :Benomyl

Product Name :Benlate, Tersan 1991, Benex.

Company Name :E.I. duPont de Nemours

Purpose :To review supplemental data to support an aerobic soil metabolism study.

Type Product :Fungicide Action Code: 627 EFGWB #(s): 92-0817 Review Time: 1.0 days

EFGWB Guideline/MRID/Status Summary Table: The review in this package contains...

161-1		162-4		164-4		166-1	
161-2		163-1		164-5		166-2	
161-3		163-2		165-1		166-3	
161-4		163-3		165-2		167-1	
162-1	41255801 Y	164-1		165-3		167-2	
162-2		164-2		165-4		201-1	
162-3		164-3		165-5		202-1	

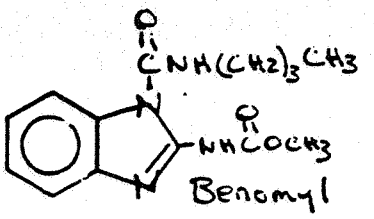
Y = Acceptable (Study satisfied the Guideline)/Concur P = Partial (Study partially satisfied the Guideline, but additional information is still needed)
S = Supplemental (Study provided useful information, but Guideline was not satisfied) N = Unacceptable (Study was rejected)/Non-Concur

1. CHEMICAL:
Common Name: Benomyl

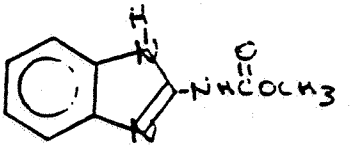
Chemical Name: Methyl-1-(butylcarbamoyl)benzimidazol-2-yl carbamate
Degradates include:
MBC = carbendazim, methyl-1H-benzimidazol-2-yl carbamate
STB = 3-butyl-1,3,5-triazolinol[1,2a]-benzimidazole-2,4(1H,3H)dione
BUB = 2-(3-butylureido)benzimidazole
2-AB = 2-aminobenzimidazole

Type of product: Fungicide

Chemical Structure:



Benomyl



Carbendazim (MBC)

Physical/Chemical Properties
Molecular formula: $C_{14}H_{18}N_4O_3$.
Molecular weight: 290.3.
Physical state: Colorless, crystalline solid; on heating it decomposes (140C) without melting.
Vapor pressure (25 C): Negligible.
Solubility (25 C): c. 4 mg/kg water at pH 3 to 10; very soluble at pH 1, decomposes at pH 13; c. 18 g/kg acetone; c. 94 g/kg chloroform; c. 53 g/kg dimethylformamide; c. 4 g/kg ethanol; c. 400 g/kg heptane; c. 10 g/kg xylene.

2. TEST MATERIAL:

N/A

3. STUDY/ACTION TYPE:

Review registrants response to a previous review of an aerobic soil metabolism 162-1 study.

4. STUDY IDENTIFICATION:

(1) No MRID # assigned: April 29, 1992 letter from Janice K. Sharp, Registration Specialist Dupont Agricultural Products, Walker's Mill, Barley Mill Plaza P.O. Box 80038 Wilmington DE 19880, Subject: Response to Questions/Comments raised in EPA Data Call in (Dated March 27, 1992) Benomyl Registration Standard: Status of Environmental Fate Guideline Requirements.

5. REVIEWED BY:

Kevin L. Poff, Chemist
Environmental Chemistry Review Section #3
Environmental Fate and Groundwater Branch/EFED

Date: OCT 5 1992

6. APPROVED BY:

Akiva Abramovitch, Ph.D., Chemist
Environmental Chemistry Review Section #3
Environmental Fate and Groundwater Branch/EFED

Akiva Abramovitch
Date: OCT 5 1992

7. CONCLUSIONS:

Aerobic Soil Metabolism (162-1)

1. The registrant has provided sufficient information to upgrade study MRID #41255801 aerobic soil metabolism 162-1 from supplemental to acceptable.

2. Uniformly phenyl ring-labeled [^{14}C]benomyl (radiochemical purity 97%, du Pont) degraded with a registrant-calculated half-life of 19 hours in nonsterile silt loam soil incubated in the dark at 25 ± 1 C and 75% of field moisture capacity. The major degradate identified was methyl-1H-benzimidazol-2-yl carbamate (MBC), which degraded with a registrant-calculated half-life of >320 days. Two other nonvolatile degradates were identified: 2-aminobenzimidazole (2-AB) at 0.8-6.2% of the applied radioactivity in the nonsterile soil, and 2-(3-butylureido)benzimidazole (BUB) that reached a maximum of 4.6% of the applied radioactivity at 3 days posttreatment.

The registrants response to the deficiencies in MRID 41255801 are as follows:

Radioactivity in the Aqueous Extracts

The relatively high level of aqueous phase (radioactivity) in question (270 day sample) is not due to the presence of an uncharacterized soil degradate. Rather, this data point should be considered an "outlier" due to inadequate extraction of the radioactivity (primarily MBC based on chromatography of the previous samples) into the ethyl acetate phase. This conclusion is supported by the following information:

1) Excluding the 270 day aqueous sample, the radioactivity in the aqueous phase of the soil extract averaged 0.6% of the applied radioactivity. Aqueous radioactivity in both the preceding sample (120 day, 0.4% of the applied radioactivity) and the following sample (365 day, 1.7% of the applied radioactivity) were much lower.

2) The higher level of aqueous soluble radioactivity in the 270 day sample was accompanied by a lower level of organic soluble radioactivity. In the 270 day sample, the ethyl acetate phase had 30.3% of the applied radioactivity and the aqueous phase 13.2% (total 43.5%). In the 365 day sample the ethyl acetate phase contained 41.8% of the radioactivity and the aqueous phase 1.7% (total 43.5%).

3) TLC analysis of the aqueous phase from the 270 day sample is almost identical with the TLC analysis of the ethyl acetate phase (Figure 1 attached). The major radioactive species in both samples is MBC.

Degradates Present in the Organic Extracts at up to 2.3% of the Applied (Approximately 0.16 ppm) were not Characterized

The "uncharacterized" component accounting for 2.3% of the radioactivity in the day 365 ethyl acetate phase was an artifact of the HPLC analysis. This artifact resulted from the sensitivity of the HPLC system to changes in the ionic strength of the sample. Because of the problem with the HPLC of the day 365 ethyl acetate phase, confirmatory analysis was done by TLC (see figure 2 attached). No other component other than MBC (major peak), 2-AB (at origin), and STB/BUB (leading edge of MBC peak) was observed. Although the confirmatory TLC was done, quantitation of the different radioactivity species was still by HPLC.

Except for this "uncharacterized" HPLC artifact, no other component in an ethyl acetate phase accounted for more than 0.3% of the applied radioactivity. (see attached for chromatograms)

8. RECOMMENDATIONS:

Inform the registrant that study MRID #41255801 and the supplemental data supporting the aerobic soil metabolism completely satisfy the 162-1 data requirement for benomyl.

The current status of environmental fate data requirements for registering benomyl and carbendazim end-use products for application to terrestrial food, nonfood and aquatic food crops are as follows:

(1) Satisfied

-161-1. Hydrolysis; EAB# 6080 (Dynamac review 2/26/86) at pH 5, the half-life of benomyl was 3.5 hr., major degradate was MBC. At pH 7, the half-life of benomyl was 1.5 hr., the major degradates were MBC (approx. 75% of total radioactivity) and (STB) at 25% of total radioactivity. At pH 9, the half-life of benomyl was less than 1 hr., the major degradate was (STB) at 80% of total radioactivity. MBC appeared to be stable to hydrolysis over the studies duration.

-161-2. Photodegradation in Water; EAB# 6080 (Dynamac review 2/26/86), Dupont AMR-420-85; Phenyl labeled [^{14}C]benomyl (radiochemical purity >99%), at 1 ppm, degraded with a half-life of < 4 hours in a sterile aqueous buffered solution (pH 5) maintained at 25 C, whether the solution was irradiated with natural sunlight or incubated in the dark. Under both conditions the major degradate (> 99% of applied) was MBC, STB was present at 1%. At the end of the 30 day study MBC represented 99% of the applied. (A PHOTODEGRADATION HALF-LIFE WAS NOT ESTABLISHED FOR MBC, HOWEVER, AVAILABLE DATA SUGGEST MBC APPEARS TO BE STABLE TO

PHOTODEGRADATION)

-161-3. Photodegradation on Soil; EAB# 6080 (Dynamac review 2/26/86), Dupont AMR-423-85; Phenyl-labeled [^{14}C]benomyl (radiochemical purity >99%), at approx. 1 lb. ai/A, degraded with a half-life of < 4 days on nonsterile silt loam soil irradiated with natural sunlight at 25 C. [^{14}C]Benomyl degraded completely in < 15 days on silt loam soil, whether the soil was irradiated or maintained in darkness. Under both conditions, the major degradate (approx. 100% of applied) was MBC, 2-AB comprised <2.0% of the applied. At the end of the 32 day study MBC represented >99% of the applied. (A PHOTODEGRADATION HALF-LIFE WAS NOT ESTABLISHED FOR MBC, HOWEVER, AVAILABLE DATA SUGGEST MBC APPEARS TO BE STABLE TO PHOTODEGRADATION)

-162-1. Aerobic Soil Metabolism; EFGWB #s: (91-0949,-50,-62) and EFGWB #92-0817 (this review) The calc. half-life of benomyl was 19 hours in nonsterile silt loam soil, pH 6.5. The major degradate was (MBC), which degraded with a registrant-calculated half-life of >320 days. Two other nonvolatile degradates were (2-AB) and (BUB).

-162-2. Anaerobic Soil Metabolism; satisfied by the 162-3 submission.

-162-3. Anaerobic Aquatic Metabolism; this review, EFGWB #s: 91-0949,-50,-62. Benomyl's half-life was not established. The half-life of MBC was 743 days in a clay loam soil, pH 7.4, that was treated with 1 ppm (equivalent to 1 lb/ai/A) [^{14}C]Benomyl and incubated for up to 365 days. (STB), the only other degradate detected reached a maximum of 7.6% of the recovered radioactivity (0.10 ppm) at 365 days posttreatment.

-162-4. Aerobic Aquatic Metabolism; EFGWB #s: 91-0949,-50,-62. Benomyl's half-life was not established. The half-life of MBC was 61 days in a clay loam soil, pH 7.3, that was treated with 2 ppm (equivalent to 2 lb/ai/A) [^{14}C]Benomyl and incubated for 30 days. (STB) reached a maximum of 28.8% of the recovered radioactivity then dropped to non-detectable at day 14. (BUB) reached 1.54-2.30% of the recovered radioactivity (0.03-0.05 ppm) immediately posttreatment-1 day posttreatment, and was not detected (<0.01 ppm) at 7 days. (2-AB) was $\leq$0.083% of the recovered radioactivity (0.02 ppm) at all sampling intervals.

-163-1. Leaching and Adsorption/Desorption; EFGWB# 90-0276,EAB# 6080,
(Dynamac review 2/26/86), Dupont AMR 426-85, Phenyl-labeled [^{14}C]benomyl and its degradates, including MBC, STB, and 2-AB were immobile (>85% of applied remained in the upper 2 inches, > 95% in upper 4 inches) in columns (13-inch length) of two silt loam (Flanagan and Seaport) and two sandy loam (Cecil and sassafras) soils. The columns were treated with <u>unaged</u> and <u>aged</u> residues at 1.2-1.6 lb ai/A and leached with 20 inches of water.

(EFGWB# 90-0276,EAB# 6080, (Dynamac review 2/26/86), Dupont AMR 425-85, Phenyl-labeled [^{14}C]benomyl and its degradates, including MBC, STB, and 2-AB were immobile in two silt loam and two

sandy loam soils as measured by batch equilibrium and soil TLC studies. Freundlich Kd_{ads} values for benomyl and its degradates (carbendazim, (MBC)) in batch equilibrium studies ranged from 6.1 to 90 and 1/n values ranged from 0.80 to 0.89; R_f values for the soil TLC were 0.00-0.16. Kd_{des} values established for benomyl and its degradates (carbendazim (MBC)) were 2.5 in a Woodston sandy loam 1.1% OM; 2.5 in a Cecil sandy loam 2.1% OM; 2.5 in a Flanagan silt loam 4.3% OM; and 2.4 in a Keyport silt loam with 7.5% OM.

-164-2. Aquatic Field Dissipation; EFGWB #90-0276, See attached review, satisfied by unaged soil column leaching and field monitoring study 00146415 (previously rejected due to the fact that only the 0-2 inch layer of soil was sampled for analysis).

-165-1. Accumulation in confined rotational crops; EFGWB #90-0434, 6/6/90, the 165-1 was satisfied for carbendazim by the submission of additional data;in the 30 day soil aging study (application rate of 1 lb ai/acre) beets, beet foliage, and barley grain all had total ^{14}C-residue concentrations <0.01 ppm while barley straw and cabbage contained total ^{14}C-residues of 0.053 and 0.026 ppm, respectively.

-165-4. Accumulation in Fish (EAB# 6250, EAB# 70858; Acc. No. 260573, Hutton, Kasprzak and Priester (1985), Bluegill sunfish exposed to 2 concentrations of carbendazim, 0.018 mg/l and 0.17 mg/l for 4 wks. showed maximum BCF's in whole fish of 27 and 23 at the low and high exposures, respectively. Peak viscera BCF's were 460 and 380 for low and high exposures, respectively. Little occurred in muscle tissue (<4 BCF) or the remaining carcass. After 14 days of depuration >94% decrease in whole fish, viscera, and muscle.

(3) Not Satisfied

-164-1 Terrestrial Field Dissipation

(4) Reserved

-164-5. Long Term Terrestrial Field Dissipation; EFGWB #80863,9/11/90, held in reserve pending review results of the terrestrial field dissipation.

(5) Waived

-163-2. Laboratory Volatility; EFGWB # 80863, 9/11/90
-163-3. Field Volatility; EFGWB # 80863, 9/11/90
-165-3. Accumulation in Irrigated Crops; SEE MEMORANDUM FROM H. NELSON TO AMY RISPEN, 8/24/90.
-165-2. Accumulation in Field rotational crops; EFGWB #90-0434, 6/6/90 (See attached review.

9. BACKGROUND :

Benomyl is a protective and eradicant systemic fungicide

registered for use to control a wide range of fungi affecting a variety of fruits and vegetables, nuts (almonds, peanuts, pistachios, pecans, watercress), field crops (barley, rape, wheat), turf, and ornamentals. It may also be used as a pre- and postharvest spray or dip for the control of storage rots of fruits and vegetables. Benomyl is also effective against mites, primarily as an ovicide. Single active ingredient formulations include dry flowable, oil dispersible, and wettable powder. (recently greenhouse uses have been removed from the label and the dry flowable has been removed from the market due to phytotoxicity problems)

10. DISCUSSION:

See conclusions above.

11. COMPLETION OF ONE-LINER:

Attached.

12. CBI INDEX:

Not Applicable.